

BELLCOMM, INC.

1100 Seventeenth Street, N.W. Washington, D. C. 20036

SUBJECT: Earth Sensing on Early AAP Missions
Case 630**DATE:** May 27, 1968**FROM:** W. W. ElamABSTRACT

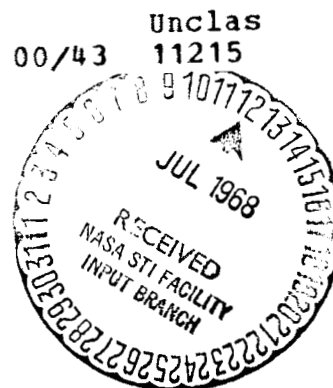
Six earth sensing experiments are recommended here for flight on the first AAP Workshop. These experiments will provide valuable data even though a higher inclination orbit than is presently planned is desirable. If the orbital inclination of the mission can be increased to 35 ° or more, the recommended experiment complement must be reexamined because other instruments become competitive.

The recommended experiments can be performed without compromising other mission objectives.

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MISSIONS (Bellcomm, Inc.) 6 p

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MEMORANDUM FOR FILE

INTRODUCTION

The Apollo Applications Program Mission 1-A has been cancelled. The 1-A mission, which was to have been flown at an orbital inclination of 50°, had as its primary scientific payload 14 earth resources and meteorology experiments. This memorandum investigates which of these experiments would provide good scientific data in a low inclination orbit (28.5°) and how these experiments could be carried and operated on an early AAP mission.

The low inclination orbit causes a change in principal meteorological objectives from testing and comparing atmospheric sounding techniques necessary for global numerical weather analysis and longer range weather prediction to making observations in support of earth based field projects investigating mechanisms of heat, momentum, and moisture transport in tropical latitudes. These field projects are also in support of the World Weather Watch and the Associated Global Atmospheric Research Program. The types of observations required are high resolution color photography, stereo photography, infrared imaging, microwave imaging, and sferics.

For earth resources the low inclination orbit greatly reduces the number and variety of ground truth sites. The objectives shift from developing, evaluating, and comparing multispectral techniques to the use of a few better understood techniques to get the type of data for which interpretation is comparatively well known from experience with aircraft borne sensors. The altitude of the AAP missions degrades the spatial resolution of these experiments and thus reduces their usefulness for earth resources purposes.

In addition, the radar scatterometry experiment to determine sea state and possibly infer surface winds over ocean areas should be included because of the importance of the objectives even though a desired range of natural conditions may not be encountered.

INSTRUMENT PAYLOAD

The AAP 1-A experiments which support these objectives are:

- S100 Metric Camera (special)
- S101 Multiband Photography
- S102 Dual Channel Scanner-Imager
- S105 Altimeter/Scatterometer Radar
- S048 UHF Sferics
- S075 Elec. Scan. Microwave Radiometer

S100 must be mounted in a pressurized volume but without optical restriction. S102 must be located partially in a pressurized volume. Others are exposed to vacuum. Orientation with respect to the local vertical and the ground velocity vector is required. All operate looking in the nadir direction. Table 1 gives data on the experiment hardware. The total launch weight is approximately 450 lbs plus return weight (magazines and film). The minimum return weight is 73 lbs based on a 14 day mission with more weight certainly desirable for a long duration mission. Weight of supporting structures or systems would be additional.

The instruments should be mounted on the MDA or AM structure such that the look direction (nadir direction during operation) is in the direction of the +Z axis or on the Port 3, Truss 2 side of the cluster which is the opposite side from where the LM/ATM is docked. If Port 3 were provided with an optical hatch, S101 should be mounted internally in the MDA for convenience of film replacement. The other experiments must be mounted external to the MDA or AM. Since a large portion of the surface of the MDA is a radiator, mounting around the structure of Truss 2 of the AM appears to have the least impact on the system. Other possibilities are a small carrier taken up in the SLA area and then transposed to Port 3 of the MDA, or mounting the experiments in a sector of the SM.

Accommodating S100 with its requirement for a pressurized environment and an optical window, its relatively large size, and necessity for film return would be the most difficult instrument mounting problem.

EXPERIMENT OPERATION - AAP 1-2. 3-A (MEDICAL MISSION)

The cluster would be oriented with the long axis POP (or more exactly perpendicular to the ground velocity vector) with the earth sensing instruments mounted on the MDA Port 3 side of the cluster. The cluster is rolled slowly around the long axis so that the earth sensing instruments are held in the

nadir position. The solar cells would operate at approximately 60% efficiency as compared to the POP mode. However, there is a savings in maneuvering fuel required, three pounds per day in the POP roll mode as compared to nine pounds per day in the straight POP mode.*

It would be highly desirable to make automated observations while the cluster is in "storage" orbit unmanned. The cluster would be oriented with the long axis POP and rolled as described above. Savings in RCS fuel are realized. The decreased solar cell output would be comparatively less of a problem than when the cluster is manned. Large capacity film magazines would be required for unmanned operation. There would, of course, be long delays in returning the film to earth as it would be brought back on the AAP 3-A CM which would also be carrying a large volume of film from the 3-A Mission itself.

FURTHER OBSERVATIONS AND SUMMARY

Flying at the planned higher altitude as compared to the 140 N.M. altitude for the 1-A mission causes a degrading of spatial resolution of the photographic and passive imaging devices. For earth resources this is a significant factor. The spatial resolution is adequate for meteorology. The flying of earth resources instruments at altitudes compatible with long duration missions requires that the performance of the instruments be upgraded to significantly improve the spatial resolution obtained.

Because the astronaut timeline for these missions is full if not overloaded, the operating control of these experiments should be automated or ground controlled with an astronaut manual override. The operation of the experiments should be enhanced by astronaut participation, but must not be limited by astronaut availability.

Simultaneous observations of the earth and stellar and celestial bodies cannot be made from the same space platform without a gimbaling capability. If earth looking data can be taken on medical missions, the required complexity for taking earth looking data on an early ATM mission would not be warranted.

The earth looking scientific objectives and instrument complement stated here are based on an assumed orbital inclination of 28.5°. If the orbital inclination can be changed to 35° then the meteorological objectives are changed. The scientific return for atmospheric sensing experiments, particularly the temperature profile sensors, increases markedly, particularly if the sensing is done during the winter season. Thus, assuming a limited capacity for carrying experiments, the instrument complement

*B. Elrod - personal communication

given here probably would be modified for a 35° inclination.

CONCLUSIONS

Worthwhile earth sensing experiments can be mounted and operated on the AAP Workshop in low inclination orbit without interference with the other mission objectives. Although the data return from earth sensing experiments would be increased in higher inclination orbits, nevertheless, valuable data will be obtained in the presently planned orbit. Earth sensing experiments should be carried.

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W. W. Elam
W. W. Elam

TABLE 1

EXPERIMENT HARDWARE DATA

<u>EXPERIMENT</u>	<u>WEIGHT</u>		<u>DIMENSIONS(SIDE IN SENSING DIRECTION UNDERLINED)</u>		<u>POWER</u>	<u>REMARKS</u>
	<u>LAUNCH</u>	<u>RETURN</u>	<u>LAUNCH</u>	<u>RETURN</u>		
S100	200	35 ea	<u>30"x30"x24"</u>	<u>10"x6"x6"</u> <u>+14"x11"x10"</u>	250W	OPERATED IN PRESSURIZED VOLUME ORIENTED + 1.5° OF NADIR
S101	30.5 lbs +1.7 lbs ea magazine	1.7 lbs ea magazine, 18 mag/33 lbs	<u>12.5"x11.5"x8"</u>	<u>4"x4"x4"ea</u>	NEG	OPERATED IN PRESSURIZED VOLUME ORIENTED + 1.5° OF NADIR; HIGH SPECTRAL TRANSMISSION WINDOW .3 - 1.0μ
S102	100	5 ea	<u>18"x8"x18"</u> <u>+9"x18"x9"</u>	<u>5"Dx6"ea</u>	60W	RECORDER (9x18x9) IN PRESSURIZED VOLUME, OTHER EXTERNAL. MOUNT TO SCAN PERPENDICULAR TO GROUND VELOCITY VECTOR. NEEDS EXTERNAL CRYOGENIC SUPPORT.
S105	50	NONE	ANTENNA <u>~118"x27.5"x10"</u> <u>+ ~10"x5"x14"</u>	NONE	80W	LONG AXIS OF ANTENNA MOUNTED PERPENDICULAR TO GROUND VELOCITY VECTOR.
S048	35	NONE	ANTENNA <u>52"Dx15"</u>	NONE	6W	ORIENTED + 5° OF NADIR
S075	30	NONE	<u>18"x18"x6"</u> <u>+6"x8"x13"</u>	NONE	20W	ORIENTED + 5° OF NADIR, + 2° DESIRABLE, MOUNTED SO SCAN IS PERPENDICULAR TO GROUND VELOCITY VECTOR

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From: W. W. Elam

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